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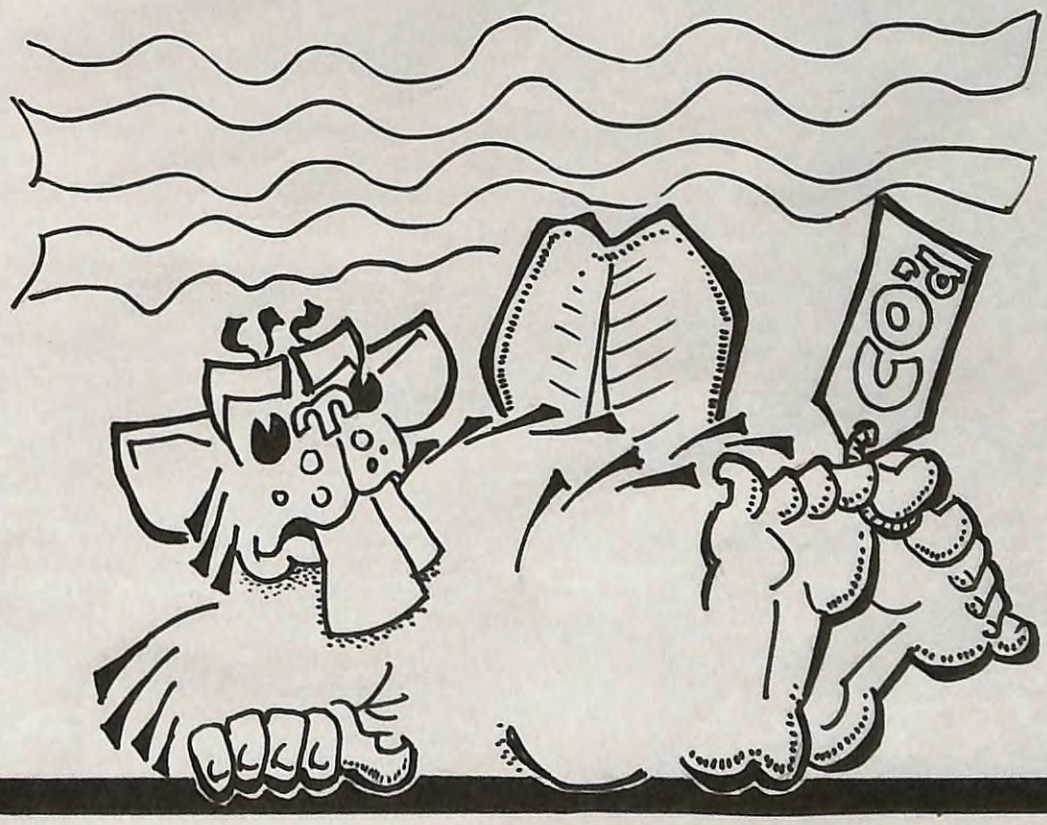
Houses Shouldn't Kill



From the Editor . . .

I am amazed at the questionable decisions that supposedly educated people make. The source of my immediate concern is the abandonment of all serious environmental actions by our new Federal government.

The politicians tell us to be patient, because they have great solutions to the real problems we are facing. They forget, or willfully ignore, the fact that communication takes place on many levels. It's not just the promises everyone can make, or the flowery language of a good orator, but equally, if not more important, the actions that are or are not taken.

What has me concerned is that the Federal government has been aggressively cutting all environmental and climate change programs outright, including programs that provide impartial information to help people make informed decisions. Many have been eliminated at a moment's notice without giving consideration to the impact the cuts are having. While some programs were fully government-funded, many were co-funded with other agencies and relied on a large amount of volunteer participation. The program cuts are taking place in a piecemeal fashion without an overall plan, which is a concern since there is a denial on the part of the government and many of their supporters that man-made activities, including greenhouse gas production, are having a devastating impact on the ecology of the world.

The message they are sending is that climate change is not a concern. They are decimating infrastructure that has taken more than a decade to develop and that has served Canadians in good stead. If changes or modifications are needed, they should be implemented, but there is no need to reinvent the wheel.

The latest cut, made near press time for this issue, has been the Energuide for Houses Program. The cut was done with a one-day notice. The people making the decision likely did not understand that the program was a tool that did performance evaluations of existing houses. It provided homeowners credible, third-party information about the condition of existing houses, and offered recommendations for cost effective and meaningful energy efficiency upgrades. Unlike programs in the past, grants were not provided merely for doing something – actions had to have measurable outcomes.

The Energuide program evaluated more than 300,000 homes across Canada. Follow-up surveys have shown that homeowners are taking action on the recommendations, upgrading their homes and saving significant energy resources. The net benefit has been not only to the individual homeowner, but also to the nation and the environment (which knows no boundaries). It also created a national database that provided a picture of the housing stock across Canada, which can be used for policy deliberations on energy and environmental issues.

The Energuide program built up an infrastructure of technicians across Canada who were independent consultants (largely generating their own leads, and investing their resources into diagnostic equipment), working with many professional builders. The Energuide program has also served renovators and suppliers and sub-trades quite well by providing independent third-party evaluations. Eliminating this service and the pool of trained technicians, is a waste of human resources and a disservice to our industry as well as the public.

In an era when government is run by bean counters with a narrow monetary focus that often ignores broader human, social and environmental values, it is surprising that the measurable benefits accruing from programs that actually can show the impact of changes, such as Energuide for Houses, are eliminated. It is ironic that just as many provinces, agencies, and other groups have recognized the value of the Energuide labeling program and begun to institute programs around the protocol, the Federal government pulls the plug on it.

Politicians may talk about all the nice things they are going to do in the sometime future. Unfortunately, actions need to be taken now. We don't have the luxury of doing nothing for a year or so until someone reinvents the wheel. If the feeling is that the current programs are not quite up to par, they should be fixed, not eliminated. There is no evidence whatsoever that what has been developed over the past number of years is not effective. It can always be improved, but you don't improve something by starting from scratch.

Richard Kadulski,
Editor

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Your House Shouldn't Kill You: Why Knowledge of Building Science Is Important

Canadian construction practices and regulations acknowledge that a house is a system. The whole is more than just the sum of a series of parts. Unfortunately, this is not always recognized. Even code-compliant installations can be unsafe.

A carbon monoxide poisoning death at Fairmont Hot Springs, in eastern BC on December 24, 1999, provides us with a case study of what can go wrong when errors or oversights compound. If even only one of the faults had been observed and dealt with, the fatality would likely have been averted.

In this case, the homeowner arrived at the dwelling at 5 pm, and at 6:43 pm was pronounced dead. A blood sample taken from the deceased showed that 57% of the oxygen carrying capacity of the homeowner's blood was saturated with CO, essentially causing oxygen starvation.

Carbon monoxide is a clear, colourless, odourless gas that is the result of incomplete or improper combustion. Blood has a greater affinity for CO than it does for oxygen, which is why it is so toxic to humans.

The main source of CO was from an overfired propane boiler that spilled its combustion products when the chimney failed to establish a proper draft. However, as we will show, there were a number of fundamental flaws with the design of the house and the installation of the two heating systems which caused this problem. Ironically, these systems were almost code compliant yet still failed to operate safely.

The coroner's post mortem investigation noted that three of six nearly identical buildings had similar heating systems, all of which generated similar CO spillage. The coroner's investigation also underlined how much variability there can be due to design and operating conditions, as investigators initially were not able to recreate the identical conditions that led to the spillage of CO from the boiler (although CO detectors were triggered in the neighbouring houses) suggesting that this kind of occurrence can be much more frequent than at first thought.

The House

The building was a one-and-a-half-year-old, side-by-side duplex condominium. The building had two floors above grade plus a full basement. The second floor was a master bedroom suite over only a portion of the main floor, and the full ceiling was vaulted, creating a two-storey open living area. The basement was fully finished with three bedrooms, two bathrooms, a recreation room, and a utility and mechanical room. The attached garage, accessible only from the exterior, was heated by the home's forced warm air system, although there was no return air from the garage.

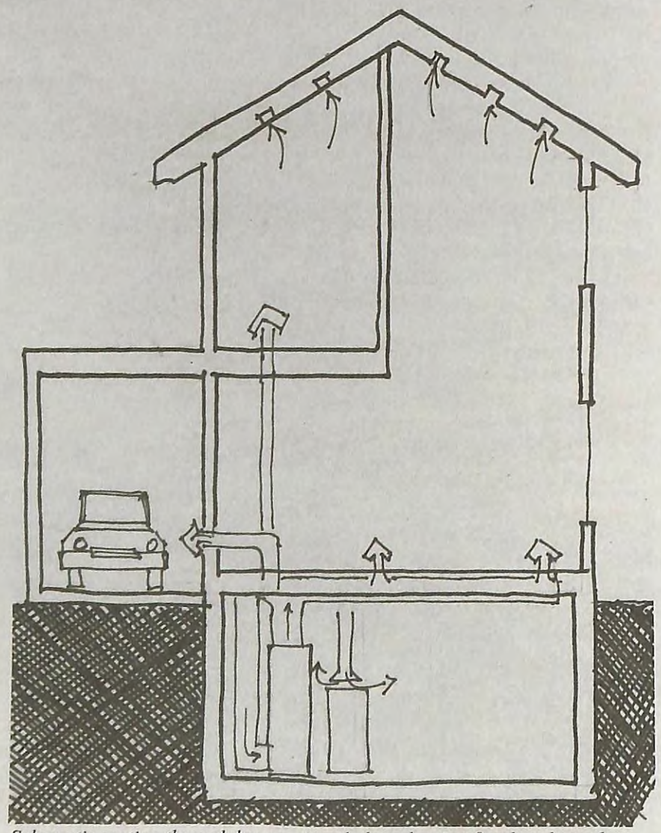
The Mechanical Equipment

The heating system for both above grade floors was a high-efficiency condensing propane forced air furnace. The basement in-slab radi-

Front of building. Right side of the building is the unit where the carbon monoxide poisoning death took place. Note the cold chimney, which has the high efficiency furnace vent termination and the 'B' vent serving the naturally aspirated boiler.

ant heating floor panel was heated by a B-vented draft hood equipped (naturally vented) boiler. The B-vent was located in a chase on an outside wall, and thus was essentially a cold chimney. The boiler had an electrically operated vent damper to limit stand-by losses and thus ensured that the chimney was cold when unused.

This house was located at 2,760 feet above sea level. For many gas-fired appliances, the installer must derate the appliance when used at over 2,000 feet in elevation. These site adjustments to combustion appliances must be made at high altitude locations because at this altitude the air density is about 5% less than at sea level. Further, some appliances also must be derated from their natural gas ratings when the unit is fired by propane. If the adjustments are not made, incomplete combustion will result. It was discovered that the installer did not properly make the adjustments for altitude



Schematic section through house. A sealed combustion fireplace heated upper floors and garage; a naturally aspirating boiler is used for heating the basement. Air leakage through stack action was increased by air leakage through pot lights in the ceiling.

One of the compounding effects allowing the CO to enter the living space was the cold B-vent serving the boiler. During cold weather, the draft in the B-vent at start-up could be non-existent or in some cases actually reversed, and became a source of cold outside air. In this case, even with the boiler's required passive combustion air, which had been installed correctly, the B-vent reversed itself and became an additional air inlet. The investigators found a considerable amount of combustion spillage into the house when the boiler was cold started.

While the investigations were being done, CO concentrations as high as 224 ppm were observed in adjoining units, suggesting that the flow reversal and CO generation were not unique examples.

Depressurization in the furnace room was enhanced by the leaky furnace ducts and by the stack action in the house. While the depressurization did not affect the sealed combustion furnace or its venting, it did have a direct effect on the boiler venting. The depressurization was enhanced because the furnace was ducted to heat the garage, essentially exhausting air from the house, increasing the home's negative pressure. In addition, with winter temperatures as cold as –27°C, there can be significant stack action in a three-level house. Cold weather stack action can induce significant pressures between the basement and upper floor ceiling, especially when air leakage through poorly sealed pot lights in the ceiling draws air out of the house.

These units were not built particularly draft free. The air leakage at the high level ceiling actually increased the basement negative pressure. As any R-2000 builder understands, it takes some care and attention to build an airtight building envelope. Today's fascination with recessed ceiling light fixtures makes this extra difficult. Even "airtight" pot lights are not completely tight. The result is that the lights present an easy exit channel for air to be driven outward. When the light is turned on, the heat from the light actually generates a small chimney action, increasing the exhaust flow. During cold weather, the stack action in the three-storey building can overpower a cold B-vent.

A challenge we face is the aesthetic image of a house so many people have: the classic picture of a house with a fireplace and chimney on the outside wall. It is an image that seems to be entrenched in our consciousness. If a fireplace must be against the exterior wall, the entire unit and chimney should be kept inside the thermal envelope. In this house, the fireplace was against the outside wall, but kept inside the insulated envelope. However, the designer added a stone veneer on the outside to maintain the image of the masonry chimney.

The Forced Warm Air Furnace

We know that most ducts in forced air systems are not particularly airtight. When a large ducted circulation system (such as the standard forced air heating system) is installed in a compartmentalized building, such as a house with its interior doors closed, pressure imbalances can be created. If the system layout is not properly balanced, the combination of furnace return and mechanical room duct leakage can contribute to significant negative pressures within the mechanical room, basement, etc. In this case, the furnace circulating fan contributed to the negative pressures in the furnace room and efficiently circulated the CO-rich combustion gas products to the bedrooms, which themselves had already contributed to entering the furnace room.

- The fact that the garage was heated with forced air from the house should have raised questions since, during the furnace fan "off" cycle, a garage becomes passively coupled to the house, even if there is no return air connection from the garage. By delivering heated air to the garage, the furnace contributes to depressurizing the house.

Operation by the Occupants

As is typical, the owner of this house returned after a prolonged absence, and cranked up the heat in the mistaken belief that by turning the thermostat up to 30°C the house would heat up quicker. The consequence was that the heating system was firing much longer than would be needed if it had been set to only 22°C. If the system had shut down when the house had reached 22°C, one can only speculate on what the peak concentrations of CO might have been and whether or not they would have been lethal.

The Coroner's Recommendations

The coroner's report made a number of recommendations. We have included the practical recommendations here, edited for brevity, and added others which experience has shown would be useful for a builder and mechanical contractor to follow, to reduce the risk to residents.

1. Return air leakage should be minimized. The return air system should be sealed. In some cases this may require sheet metal return air ducts.
2. There should never be a cold chimney, located largely outside the heated envelope of the house, whose performance is made worse by use of a flue damper. Chimneys should always be placed within the heated space of the house.
3. Never heat a garage with the home's forced air heating system. In effect, this is exhausting air out of the house. Any large exhaust fans, in this case the furnace supplying heated air to the garage, needs compensating make-up air.
4. Provide make-up air whenever there is a naturally vented combustion appliance in the house, and when there is a large exhaust appliance.

Commissioning the Heating System

1. This was not done; the boiler was operating significantly below the manufacturer's required minimum temperatures and had not been derated for the altitude. The installer must verify the temperature rise at the appliance, measure the gas input, and do a flue gas analysis.
2. At the start-up of new appliances, a spillage test in accordance with CGSB 51-71 should be done. This is part of the protocol used for all Energuide evaluations, whether existing or new houses. It is not an onerous test, but a very important one, especially in homes with open combustion appliances.
3. All new appliances should be certified to ensure they can withstand depressurization of 10 Pascals, and at 10 Pa their flue gas products produce no more than 100 to 200 ppm of CO.
4. It would be much more effective to keep chimney flues inside the house. To produce enough draft, and to overcome the negative pressure due to stack action, a chimney should be as warm as the house, and be as tall as the highest part of the house. Avoid flues on the outside of the house, whether they are insulated or not.
5. All new and renovated dwellings should be equipped with a CO detector. The 2005 National Building Code does require a CO detector be installed in or adjacent to each bedroom. However, a CO detector is only a safety valve. Conditions that can allow flue gas spillage should be avoided in the first place. ☼

Factor 9 Home: A New Prairie Approach

More information on this innovative and very energy efficient demonstration home is available on the project's web site at *www.factor9.ca.*

For more information on Energy Star appliances and listings of qualified products, check the Energy Star web site: *oee.nrcan.gc.ca/energystar*

A new home currently under construction in Regina is intended to show what a Factor 9 house can look like. And it need not feel or look like a spaceship, but rather can feel at home in today's communities and be built with currently available materials and technologies. This house can be considered to be a natural successor of the Saskatchewan Energy Conservation house built in Regina in the mid 1970s and the Advanced Houses built in 1993. Each was a showcase of the latest technologies and construction practices to achieve high performance in homes.

What is a Factor 9 Home?

It is a home that will use 90% less energy than a conventional 1970s home of the same size, use 50% less water, and feature other environmental approaches that will reduce the impact of the home.

Why Factor 9?

This is the number that one arrives at when looking into the future of what the energy use of homes should be if we are to achieve sustainable conditions in the world.

- Anticipated future population growth: factor 1.5
- Future consumption growth per person: 3
- Future reduction needed in greenhouse gases: 2

Thus, 1.5 x 3 x 2 = 9

Reducing Energy Consumption

An example of the ways energy consumption can be reduced is seen in the appliance selection. Appliances for the house (fridge, freezer, clothes washer, and dishwasher) will all be Energy Star appliances. To further improve the energy performance of the fridge and freezer, Green Plugs™ will be installed. The Green Plug™ is a plug-in device that lowers the electrical voltage to about 106 volts after the refrigerator or freezer has started. The lower voltage results in lower resistance losses that translate into electrical savings.

Rob Dumont has successfully used Green Plugs™ on the refrigerator and freezer in his home for the past 13.5 years. His refrigerator has an Energuide Rating of 432 kWh per year. The measured consumption for a one-year period was 302 kWh per year – a saving of 30% compared to the Energuide rating. A large part of the energy saving is due to the Green Plugs™.

High Efficiency Gas Furnaces

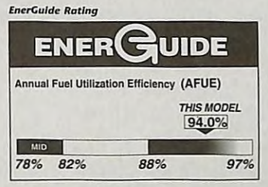
Condensing gas furnaces are the most energy-efficient furnaces available on the market today. They are an ideal choice as a new or replacement furnace for virtually any home serviced by natural gas.

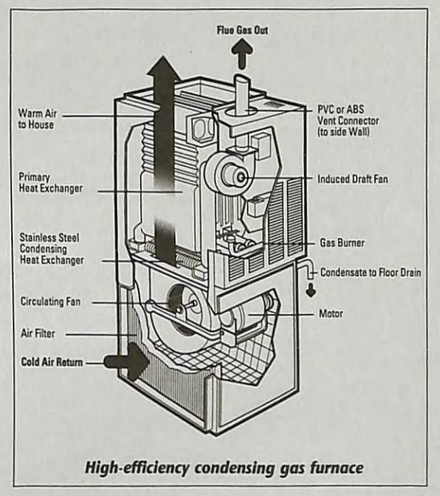
The condensing process reduces the temperature of the flue gases to the point where they can be vented through a PVC or ABS plastic pipe out a side-wall of the house. This eliminates the need for a chimney, which is a major source of heat loss in homes with old furnaces. However, there is still a large quantity of moisture in the flue gases, so it is advisable to take the vent pipe up through the roof. This is especially important to consider in homes located on small lots in urban areas, as the moisture discharged could cause problems to the house as well as the neighboring house.

Condensing gas furnaces have an annual fuel utilization efficiency (AFUE) of between 90 and 97 percent, compared with AFUEs of about 78 to 84 percent for standard efficiency units. Because of their increased efficiency, condensing gas furnaces use 33 to 38 percent less energy than old models and 10 percent less energy than a standard mid-efficiency model. This helps reduce environmental emissions that contribute to climate change, urban smog and other air pollution problems.

The incremental cost for the furnace itself, depending on unit size and features, varies from $500 to $1000. The extra cost for a high-efficiency condensing gas furnace will be quickly recovered through energy cost saving. In the case of retrofits, an older house with annual gas costs of $800 for heating with an old gas furnace could save about $300 a year by switching to a condensing gas furnace with an AFUE of 96 percent. Specific savings will vary based on occupant lifestyles, climate conditions, and gas costs.

The preferred high-efficiency furnaces will deliver greater energy savings by using a variable-speed, direct-drive electronically commutating motor to run the air circulation. Such a unit is especially important to use in homes where the fan is run continuously or for extended periods as part of the filtration and ventilation system. The variable speed motor can significantly reduce electricity consumption while providing better heat distribution.





High-efficiency condensing gas furnace

How can you tell the level of efficiency of a gas furnace? Look for its EnerGuide rating which will be on the back page of the manufacturer's brochure. The higher the rating, the more efficient the model.

Or look for the Energy Star symbol which can be found on the furnace, on the packaging or in promotional or educational literature. Only the top energy performers are eligible to use the Energy Star symbol - residential gas furnaces must have an AFUE rating of 90 or higher to qualify. Energy Star furnaces are listed on the Energy Star website.

When specifying heating systems, builders should always consider these higher efficiency units. And always make sure the heating contractor determines the right size of furnace for the home. A heat loss and heat gain calculation must always be done. ☼

More information is available at *energystar.gc.ca* or *oee.nrcan.gc.ca/equipment*

For information on the R-2000 Program, contact your local program office, or call
1-800-387-2000
www.R-2000.ca

Passive Houses: Ultra Low Energy Houses from Europe

There is much interest in moving the goalpost for energy efficient performance of new construction. CMHC along with government and industry partners is launching a Net Zero Energy House initiative. In various regions builders and developers are moving towards totally grid independent developments. In the US, a number of projects and even subdivisions are touted to be net zero energy homes.

Everyone's goal is to have a home that uses low levels of energy, and ideally, for which all of the energy consumed on an annual basis is generated on site so that the homeowner in effect has no utility bills. The real challenge is how to define a zero energy house, and how easily or practically it is to meet the performance goals.

The Europeans have been promoting the "Passive House." "Passive House" refers to a construction standard for residential buildings in which the space heating needs are reduced by passive measures to the extent that a conventional heating system need not be installed. This can be achieved by using a variety of technologies, designs and materials that are already available. Passive Houses provide a comfortable indoor climate in summer and winter without needing a conventional heating system. The ventilation system is adapted to also provide any additional heat that might still be needed.

The standard has been named "Passive House" because it relies on passive heat inputs – by solar radiation through the windows and by the heat supplied by appliances and occupants – which should in theory be enough to keep the building at comfortable indoor temperatures throughout the heating season. It is a part of the Passive House philosophy that most energy efficient appliances are used to minimize other sources of energy consumption in the building, especially electricity for household appliances.

The Passive House standard originated in Germany and in many respects it is similar to the Canadian R-2000 Standard. The key difference is an aggressive energy performance target for allowable building heat loss of about 15 kWh/m²/year (4,755 BTU/Sq.ft./year) depending on the climate. This represents about 80% less heating energy than is required by German energy standards for new buildings and is lower by at least a factor of 4 compared to the energy consumption levels of new buildings designed to current European standards. The minimal heat requirement of the Passive House can be supplied by heating the supply air in the ventilation system – a system that is necessary in any case.

The goal for total energy demand in the home, which includes space heating, domestic hot water and household appliances is less than 42 kWh/m²/year.

The Passive House targets are more aggressive than the R-2000 standard which has a target for space heating and domestic hot water which is about 75 kWh/m²/year (23,775 BTU/Sq.ft./year).

The Passive House initiative has been highlighted by the European Union CEPHEUS (Cost Efficient Passive Houses as European Union Standards) project. This is a demonstration that involved building and monitoring about 250 housing units in five European countries. The objective was:

- To demonstrate the technical feasibility of achieving the targeted energy performance at a low incremental cost (ideally offset by the cost savings) for a variety of different buildings and designs in a variety of European countries and, over the whole year, produce zero greenhouse gas emissions;
- To study consumer acceptance and user behaviour under real-world conditions;
- To test how easy it would be to implement the Passive House standard throughout Europe in a cost-efficient manner;
- To let people experience the Passive House standard hands-on at several locations;
- To spur development of energy- and cost-efficient building designs and accelerated market introduction of individual, innovative technologies that meet Passive House standards.

The Passive House philosophy builds upon two basic principles:

1. Optimize the essential elements

The key elements of a building should be optimized: the building envelope, the windows and the ventilation system (required to maintain acceptable indoor air quality). By improving the efficiency of these components it is possible in many cases to eliminate a separate heating system and thus provide savings that can cover a large portion the incremental costs of the envelope upgrades.

2. Minimize heat losses first

Passive Houses focus on energy conservation first, to reduce heat loss as much as possible. Computer simulations have shown that under Central European and comparable climatic conditions such a strategy is more efficient than strategies relying primarily upon passive or active solar energy use. Many of the locations in Europe where these houses have been built are at latitudes that are north of many populated regions of Canada, and the climate is similar to southern Ontario or southern BC (3400 to 4600 Degree Days °C, and a winter design temperature to -14 °C).

Monitoring of 114 Passive Houses showed space heating energy saving of 80 to 90%. When domestic hot water and lights and appliances were added in, the total energy consumption was still less than 50% of that in conventional new homes. The difference is accounted for by energy use within the dwelling for lights and appliances.☼

For more information on the Canadian Net Zero Energy Healthy Housing initiative, and to receive the Request for Expressions of Interest call 1 800 668-2642 before June 30, 2006

Key Elements of a European "Passive House"

1. Airtight Well Insulated Building Envelope

Passive Houses have an airtight, well-insulated building envelope that minimizes thermal bridging and air leakage. The shell of the house should be insulated to achieve a U-value that does not exceed 0.15 W/m²K (0.026 Btu/h/ft²/°F). This is the same as an overall R-38.

The airtightness must be less than 0.6 air changes per hour at 50 Pascals.

2. Efficient Heat Recovery and Supplementary Air Heating

A continuous supply of fresh air is required to ensure occupant comfort. The airflow is designed to mechanically deliver the amount needed to maintain excellent indoor air quality since ventilating by opening windows is not a workable strategy. Getting a sufficient volume of fresh air is not just a question of comfort, but a requirement for healthy living conditions. A high efficiency (75% or more) heat recovery ventilator recovers the heat in the exhaust airflow to the incoming fresh air. Supplementary heat can be added when needed to the ventilation air.

The ventilation system must use high efficiency DC (direct current) motors and a low-pressure system. The energy efficient motors should consume 0.4 W/m³/hr or less.

3. Passive Solar Design

South-facing Passive Houses also optimize solar gains that could provide enough solar energy for about one-third of the reduced heat demand of the house. In most cases this also requires the use of high performance windows, typically triple glazed low-e glazing and insulated frames. These types of windows can collect more heat than they lose. The benefit is enhanced if the main glazing areas are oriented to the south and are not shaded.

Energy-efficient window units (taking into account the glazing and frames combined) should have U-factors not exceeding 0.80 W/m²K (0.14 Btu/h/ft²/°F or a minimum R-value of 7) with solar heat-gain coefficients around 50%.

4. Energy Efficient Lights and Appliances

Household appliances, lighting and electronic equipment can consume significant quantities of electricity, and indirectly, contribute to space heating and overheating. New equipment that is more efficient and has a lower electrical consumption is now on the market, without any loss of comfort or convenience. Use of compact fluorescent lighting and other energy efficient appliances must be used to achieve energy savings.

5. Renewable Energy

Cost effective solar thermal systems can contribute about 40–60% of the low-temperature heat demand of a Passive House through solar water heaters and passive solar gains. The small energy demand of a Passive House also makes it possible to consider other renewable energy options, including electricity, so that over the year there will be enough renewable energy collected on site to completely offset the need to purchase energy, making the Passive House fully climate-neutral.

Technical Research Committee News

Canadian Home Builders' Association

Passive HRVs

We understand the importance of providing managed air change for our homes. That is the intent behind ventilation standards. Increasingly, heat recovery ventilators are being used in new homes. However, there is a cost associated with an HRV, and suppliers are always trying to provide alternative approaches.

Nu-Air Ventilation Systems is one manufacturer that has a passive HRV that is attached to the forced warm air heating system. The furnace fan draws fresh air into the home while an equal amount of stale air is exhausted to the outside. As with other HRVs, incoming fresh air is filtered before flowing through the heat exchange core. Stale air flows through the cross-flow heat exchanger and transfers the heat to the incoming fresh air. Warm, fresh air is distributed to each room of the house through the furnace duct system. Automatic humidity control is available with a motorized damper (MD) option.

The passive HRV only operates whenever the furnace circulation fan is on. How much air do the supply air ducts draw into house when they're hooked up into the furnace return air? Do installers take measurements to verify the intended airflow like they should? If the installer does not take care to properly size and locate the ducts, and to confirm airflow readings once the system is installed, there is no guarantee that the unit will provide much air change for the house.

NRCan is undertaking a study to see just how effective these systems are as installed. There is a concern that, because of the importance of the quality of the installation, these types of systems may not be performing as intended.

The Technical Research Committee (TRC) is the industry's forum for the exchange of information on research and development in the housing sector.
Canadian Home Builders' Association, Suite 500, 150 Laurier Ave. West, Ottawa, Ont. K1P 5J4
Tel: (613) 230-3060
Fax: (613) 232-8214
e-mail: chba@chba.ca
www.chba.ca

Compact Fluorescent Lamps and Mercury

With the increased used of compact fluorescent lamps (CFL), questions have been raised about the safe disposal of old CFL lamps when they are replaced, especially since fluorescent lamps contain mercury. However, the amount of mercury used in CFLs (to help the bulbs produce light) is very small. In a typical CFL, there will be 5 milligrams of mercury, compared to 25 milligrams in a watch battery, 500 in dental amalgams, 500 milligrams to 2 grams in a home thermometer, or 3 grams in a tilt thermostat.

CFLs are safe to use in a home because no mercury is released when the bulbs are in use and they pose no danger when handled properly. Should a CFL break, the greatest health risk is getting cut by glass shards. The mercury may not even be noticed because there so little of it to begin with. Five milligrams - the average amount in a CFL - is about the size of the very tip a ballpoint pen. Also, the mercury will be in vapour form or absorbed on the lamp walls, the metal lamp ends or other bulb components. At the end of a bulb's rated life, very little of the mercury is available for release into the environment.

Make-Up Air Guidelines

At times, make-up air must be provided to a home to avoid excessive depressurization. With the increasing popularity of large exhaust appliances like barbeque cooktops and semi-industrial range hoods, there is a real concern about how best to provide required make-up air. At some times of the year, that make-up air will also have to be tempered.

A number of years ago, the R-2000 program prepared a make-up air guidelines document. The document has been undergoing revision to update it. CHBA intends to prepare a short summary document.

Database of Alternative Solutions to Code Requirements

With the introduction of the new objective-based National Building Code, there is a possibility that more alternative solutions not explicitly identified in Part B of the Code, will be proposed. To minimize "reinventing the wheel," attempts are being made to create a national database of alternative solutions to the code. Who will be taking the lead and how is not yet certain. It could be as simple as a central location for links to provincial authorities where local decisions are posted, or a separate database.

Environmental Chemical Sensitivity is Widespread

We've become accustomed to living with synthetic products of all kinds, from consumable products to building materials to household items and toys. The past half-century has been the golden age of chemistry with the slogan "better living through chemistry."

If you look around your home or office, you will be hard pressed to find many products made from completely natural materials. Around your construction site, you will find many synthetic products, not just paints and adhesives, but also construction and finishing materials, even construction tools.

At home, look in your kitchen. How many foodstuffs do you have in your pantry that have been there for months, if not years, and are still edible, compared to the fresh produce or organic food that acquires a patina of mould and fungi and deteriorates in a matter of days? Look at the fine print and you need to be a chemist to understand what gets put into the package.

We are told that all these chemicals and synthetic products are safe. However, testing is normally done only for a few of the chemicals and that testing is done in isolation with a select group of people - often healthy adults in a workplace environment - for relatively short periods of time.

Long-term exposure to the large number of chemicals, even at low levels, takes a toll on the human body. A study of a randomly selected population sample done by researchers at the State University of West Georgia and the Georgia Institute of Technology found that about 12% of the population suffers from multiple chemical sensitivity (MCS), a condition in which individuals experience reactions from exposure to low concentrations of common chemicals. About 1 to 2% of the population is sufficiently affected that they cannot function properly, leading to an inability to work.

Individuals with MCS have an acute hypersensitivity to the chemicals in everyday substances which can include household cleaning agents, pesticides, fresh paint, new carpeting, building materials, newsprint, perfume, and other petrochemical-based products. Individuals with MCS may experience headaches, burning eyes, asthma symptoms, stomach distress/nausea, dizziness, loss of mental concentration, and muscle pain. In more extreme situations, some individuals may suffer fever or even loss of consciousness at times.

MCS is often triggered by an acute one-time exposure to a specific toxic agent or chronic exposure to one or more toxic substances, even at low levels. After the condition is initiated, a wider range of substances can cause subsequent reactions. People that suffer MCS respond best by having a relatively chemical-free living space and avoiding chemical exposures. Some common medical treatments, including use of common antidepressants, are more likely to harm than help.

CMHC's Healthy House initiative has recognized this and provides valuable tools for designers and builders for the construction of healthier home environments.

about 12% of the population suffers from multiple chemical sensitivity (MCS); about 1-2% are affected seriously enough not to be able to function properly

Building Materials for the Environmentally Hypersensitive is a very valuable sourcebook for homeowners and building professionals concerned with reducing air contaminants within the home. The book features 180 commonly used products in home construction, identifies which products may be treated with pesticides, formaldehyde and adhesives, and how to select products with the least health impact. It provides information needed to evaluate products and choose those with the least toxicity.

The CMHC publication, and other healthy housing information is available on CMHC's web site www.cmhc-schl.gc.ca under "Healthy Housing."

Wet attics and ventilation

Prolonged wetness in a roof structure can rot out the roof sheathing. Often this is first noticed when the roof is re-shingled. If the ceiling leaks only in the spring, it may be the result of ice that has been forming on the sheathing during the winter as it melts when a warm spell arrives. Water stains or evidence of mould may be observed on the sheathing, rafters, or trusses when the attic is inspected. The insulation may have been packed down or stained by water or ice. The smell of a mouldy attic will enter the house under certain weather conditions, usually in summer.

The usual response is to increase attic ventilation. This is the wrong approach. Attic ventilation is overrated. In winter, the cold outside air cannot hold much humidity or carry moisture away from the attic. In summer, attic temperatures are more often affected by the sun and shingle color than by the amount of ventilation. In some cases, adding ventilation will actually put more moisture into the attic and make the problem worse.

The best way to fix a wet attic is to stop air movement from the house. If the attic is properly sealed there should not be a need for more attic ventilation.

Recent CMHC research showed that identical attics, one unvented and the other vented to code, have much the same humidity and temperature. Computer models show that attics in damp coastal climates may actually be drier with less ventilation.

Attic ventilation is overrated. Cold air cannot hold much moisture to remove from the attic; summer attic temperatures are affected by the sun and shingle color rather than by the ventilation.... Adding ventilation could put more moisture into the attic and make the problem worse.
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Proper ventilation

Building codes require attic ventilation. Ventilation may make a difference in a borderline situation. The requirement for attic vent sizing is nominally 1:300 (or one sq. ft. for each 300 sq. ft. of attic floor area). If you wish to improve your attic venting, ensure that it is as well distributed as possible. Do not worry about meeting the 1:300 requirement exactly.

It is important to remember that attic ventilation is driven primarily by wind. In order to ensure thorough venting, the vents must be distributed between the soffit and a higher point on the roof -- at the ridge, gable end, or high on the roof surface.

Vents need to be screened to keep out animals and insects. If the vents are in the soffit, there must be a space between the roof sheathing and the top of the insulation for the ventilation air to pass. Commercially available plastic or cardboard forms, or carefully trimmed pieces of rigid foam insulation can be used.

Ceiling Air Sealing

A house is like a chimney -- a container of warm air surrounded by colder air. All winter, a heated house is trying to push air through the top floor ceiling into the attic. There will be little air leakage in the middle of sheet of drywall or in the middle of an unbroken plaster ceiling. Air leaks are usually found at penetrations or discontinuities. There may be many air leaks where partition or bearing walls meet the ceiling or around the perimeter of the house where the attic floor (or top floor ceiling) meets the outside walls. All discontinuities should be inspected and sealed if necessary.

One of the worst culprits is the ceiling pot light in top floor ceilings. Safety regulations prevent the sealing of many types of pot lights, especially the older non-insulated housings. House air is moved into the attic through the holes in the housings. Even "sealed" or "air-tight" pot lights have some leakage that allows considerable quantities of air to pass through them. The heat generated when the light is turned on makes the light act as a small chimney. The only way to deal with the pot light is to avoid using them on the top floor ceiling or create an airtight enclosure above the pot light.

Bathroom fans must be properly vented and need to be ducted directly to the outside. If the ducts are located in the attic, the ducts should be solid metal rather than flex duct, and insulated with a vapour barrier and the duct should be sloped to the outside.

Plumbing stacks and chimneys are another major source of air leakage. These must be air-sealed where they pass through the attic floor.

Dropped ceilings in the room below will often conceal a direct connection to the attic.

Some houses have heating or air conditioning ducts or equipment in the attic. These can be the major source of air leakage and heat loss in the attic. ☼

Attic Venting, Attic Moisture and Ice Dams. *CMHC About Your House (CE13)*

A Tale Of Two Worlds

With the evidence now clear that human activity has generated significant climate change, serious action must be taken to mitigate our impact on the environment. While making drastic reductions in our energy use today will have little short term impact, it will set us in the right direction to correct the damage we have done over the past two centuries.

To deal with the changes, much of Europe is demonstrating a renewed sense of purpose on energy issues. The European Commission has set a target of twenty per cent energy savings by the year 2020 within the European Union (EU). This has led individual countries to take action. In Portugal, the country's cabinet approved a law requiring all homes built there to have solar energy panels as part of the structures' basic design. This measure is expected to save nearly fifty per cent of the average family's current energy bills. In the UK, aggressive energy efficiency standards are being drafted for buildings. Even China is drafting stringent energy efficiency standards. Although there may be challenges with the proper implementation of these goals, the intent and message is there.

In North America, the US Department of Energy is cutting funding for energy efficiency programs. US agencies and programs are facing severe cutbacks, just as the world is recognizing the importance of the need to reduce energy consumption. Layoffs at government laboratories are in the offing, and funding cutbacks are so severe that researchers have no means to go to conferences and meetings to present the findings of their research. And scientific reports have been suppressed or "edited" to present the political line, not the research findings.

In Canada, the new government is beginning to show its cards, and the signals are not good. Government researchers are being told not to talk. There is not a peep about the environmental problems associated with the oil industry (especially the tar sands), and we are seeing the elimination of public information programs that were raising such issues. It seems that we are about to join the ranks of the ostriches – the US and Australia – in denying that we may be part of the global problem. ☼

Building Membranes: Vapour and Air Permeance Permeance

Building membranes are integral parts of North American Buildings. Some are installed beneath exterior claddings to reduce the risk of water entry into the wall systems. Others are used for controlling vapor diffusion though the building envelope or as the airtight element of the air barrier system.

In order to determine the suitability of a membrane for its intended application, it is necessary to have reliable information on its physical properties. A paper prepared by the Institute for Research in Construction presents the water vapor permeance, the air permeance, and the water absorption coefficient for 18 common building membranes that are used today.

At the design stage most of the membranes can be considered to be the airtight element of air barrier systems and as part of the second line of defense against rainwater penetration. The membranes have a range of values for water vapor permeance so they require careful consideration on their appropriate location to deal with vapor diffusion control strategies for exterior walls and to prolong their service lives.

Six-mil polyethylene is commonly used for vapor diffusion control as well as for air barrier houses in heating climates.

Paper-based membranes, such as "10 minute paper", "30 minute paper", "60 minute paper" and "# 15 felt" are used as part of the moisture barrier behind claddings for rainwater penetration control of houses in all climatic conditions.

Spun-bonded polyolefin membranes are used to wrap the exterior walls to function as the airtight element of air barrier systems as well as part of the second line of defense for rainwater penetration control.

When deciding on products to use, the permeability, airtightness, and water absorption need to be considered. For example, information on vapor permeance helps assess the ability of the membrane to allow or resist the transfer of water vapor across it in the presence of a vapor pressure difference.

Information on the air permeance helps assess the suitability of the membrane to be used as the airtight element of the air barrier system.

The water absorption coefficient can be used to assess the membrane's ability to resist water penetration.

Such an analysis helps to select the membrane to give the optimum performance of a given envelope component for a given geographical location and expected indoor climate.

The air leakage of all membranes except the spunbonded polyolefins and the two perforated polyethylene membranes confirm that most the membranes on the market are close to or less than that of interior gypsum board (½ in.) with an air leakage of 0.188 L/m^2 s. Gypsum board is being used as the airtight element in the air barrier system of many building envelopes, so if they are installed with careful attention to sealing details, they can be the airtight element of an air barrier system.

Unlike the air leakage, the vapor permeability varies based on type of material, so different vapour diffusion strategies can be considered. It is important to note that some materials have a uniform permeability – such as polyethylene and spun bondended polyolefins. Others vary according to relative humidity. These latter allow more vapour passage at higher humidities. The benefit of these kind of materials is that should there be an accumulation of moisture, they allow the passage of water helping to dry out the assembly, rather than allowing the moisture to build up.

The tests noted that even the very permeable gypsum board, when coated with a regular primer and latex paint provides vapor diffusion resistance at low relative humidities.

Low diffusion drywall primer paints (not tested in this study) are on the market. These paints are being used as the vapour barrier in airtight drywall construction assemblies.☼

Vapor Permeances, Air Permeances, And Water Absorption Coefficients Of Building Membranes *(document NRCC-46885), by Mavinkal K. Kumaran, John C. Lackey, Nicole Normandin, and David van Reenen, Institute for Research in Construction, National Research Council of Canada*

Membrane	Vapour Permeance (ng/m^2-s-Pa)				Air Leakage (L/m^2-s)	Water Absorption (g/m^2-s)
	30%	60%	80%	100%		
10 minute paper –I (Asphalt Impregnated)	532	1190	2140	4170	.49	0.93
10 minute paper –II	425	1070	2100	4710	.069	0.99
30 minute paper –I (Asphalt Impregnated)	1220	2370	3740	6170	.29	1.12
30 minute paper –II	740	1700	3220	7230	.41	0.93
60 minute paper –I (Asphalt Impregnated)	2870	2870	2870	2870	.52	1.09
60 minute paper –II	2160	2780	3660	4950	.41	1.10
#15 Felt-I (Bituminous)	176	315	723	3500	.018	0.48
#15 Felt-II (Bituminous)	44	84	244	4010	.15	0.44
#15 Felt-III (Bituminous)	291	295	581	3110	.15	0.51
Spun Bonded Polyolefin-I	1060	1060	1060	1060	2.2	5.2
Spun Bonded Polyolefin-II	2370	2370	2370	2370	.0034	0.57
Spun Bonded Polyolefin-III	835	835	835	835	1.7	not tested
Spun Bonded Polyolefin-IV	4370	4370	4370	4370	.028	0.31
Spun Bonded Polyolefin-V	3170	3170	3170	3170	.018	0.24
Polyamide	76	159	497	6320	negligible	0.26
Perforated Polyethylene-I	1070	1070	1070	1070	4.5	2.63
Perforated Polyethylene-II	277	277	277	277	.69	0.15
Vinyl Wall Paper	169	259	382	551	negligible	0.25
Primer (one coat on □" drywall)	1850	2540	3240	3960	.0013	2.00
Primer & paint on □" drywall (one coat primer, two coats paint)	289	565	1140	2460	.0001	1.60

Re: P2000 Rigid Board Insulation

The Nova Scotia Homebuilders have issued a memo pointing out that P2000 Insulation (CCMC #13180-L and 13202-L) have been evaluated as an insulation in conformance with NBC 9.25.2.2 AND CAN-ULC S701-01, T*ype 1 Thermal Insulation, polystyrene, Boards and Pipe Covering.*

The insulation has no affiliation with the R-2000 program.

P2000 has been tested and rated by CCMC as having an R value of 3.7 per inch thickness. This is contrary to some literature claiming an equivalent rating of R 27 per inch thickness.

Product Alert: Misleading Advertising Claims

Interkek Testing Services NA Inc, the laboratory that performed some tests on the product, have also issued a letter indicating that their name has been used in connection with misleading R value claims by some distributors of P2000 foam insulation.

Information:
Nova Scotia Home Builders Association
Tel: 902-450-5559

This is a good reminder that caution needs to be used when confronted by marketers making outlandish claims. This is especially true of the various radiant insulation products on the market. But extravagant claims have also been made in the past for other systems, including exterior insulated finish systems and a variety of paint products, to name only two.

If something is touted to provide miraculous results, and it seems to be too good to be true, then it probably is. Claims need to be considered with care and an assessment made using building science principles.

Energy Answers

Rob Dumont

How can I tell if my air-to-air heat exchanger is working properly?

For those not familiar with an air-to-air heat exchanger, it is a device that provides ventilation to a house or apartment while recovering heat from the exhaust air. The more common name for an air-to-air heat exchanger is heat recovery ventilator (HRV).Usually, the HRV exhausts from the bathroom and kitchen areas and supplies outside air to the return-air side of a warm air furnace.

Here are five checks that I would recommend:

1. Clean the grills on the outside of the house. Most of the grills will have a bird screen on them, and, over time, the bird screen can become covered with lint, dust, dirt, cobwebs, leaves and other detritus. When I checked my own house this spring, the intake grill had become almost completely blocked. A neighbour's overhanging tree contributes to the problem. When the intake grill is blocked, and the exhaust grill is still open, you no longer have any heat recovery - you essentially just have an exhaust fan. With the intake grill blocked, the exhaust fan will create a negative pressure in the house, and you do not get the benefit of fresh air. If you have any atmospherically-vented combustion equipment such as a fireplace or a natural draft water heater, the exhaust fan can cause these devices to backdraft. I would recommend that you perform this grill check twice a year.

One early heat exchanger manufacturer a number of years ago used a fly screen instead of a bird screen on the intake grill for the house. The fly screen would be completely covered very quickly with dirt and block the flow. That is why, typically, the intake screens have a ¼" screen.

2. Check and clean the air filters on the HRV. In my house, I find that cleaning the filters about twice a year is sufficient. In some parts of the country with dirtier air, more frequent cleaning may be needed.

3. Check the core of the HRV. The core in most HRVs is a set of plates that allow two air streams to pass each other, with the heat being transferred from the outgoing air stream to the incoming air stream. Many HRVs have removable cores that can be cleaned using a garden hose. The core can get dirty from air leaking past or around the air filters.

4. Clean the fan. Most HRVs use forward-curved centrifugal fans, and the cup shaped blades tend to accumulate dust and dirt over time. An old toothbrush and a vacuum cleaner are handy for this cleaning job. I once lived in a house that had a continuously running central exhaust fan. Over time the fan started to make a lot of noise. When I examined the fan, I noticed that the cup-shaped blades had almost completely filled with dust and dirt, and that chunks of dirt had then fallen out of some of the blades, causing a lot of vibrational noise because of imbalance on the rotor. Cleaning the fan resolved the noise problem and greatly improved the air flow.

5. Measure the air flow on the intake and exhaust sides and adjust the flows to make sure they are balanced.

The most common way to measure air flow is to use a flow grid, a type of averaging Pitot tube that is placed in the duct. Most HRV installers have this flow grid. A low cost alternative way to measure flow is to use a standard large plastic garbage bag and a stopwatch at the HRV inlet and outlet. The exhaust flow is usually easier to measure, as the exhaust flow will inflate the bag. If the bag has a volume of 7 cubic feet, and it takes 8 seconds to fill, the volume flow is 7 cubic feet/8 seconds x 60 seconds/minute or 52.5 cubic feet per minute. For most houses you want a minimum of about 60 cubic feet per minute of flow.

CMHC completed a study in 1999 on pollutants in HRVs (Identifying and Removing Pollutants from Heat Recovery Ventilators). A Research Highlight summarizes findings from that study. The Highlight is available from CMHC at www.cmhc-schl.gc.ca/en/index.cfm, and follow the industry professional links to Research Highlights.

One of the implications of the study was as follows: "To ensure that consumers are getting the best value and performance out of HRV systems, manufacturers, installers, and builders have to improve education and awareness on the operation and maintenance of these systems."

NRC·CNRC

Public Review of Three Proposed Code Changes

By John Archer

The Canadian Commission on Building and Fire Codes (CCBFC) agreed at its last meeting in January 2006 to take proposed changes on three issues — hot water delivery in buildings, plumbing fitting standards, and insulating glass standards — to national public review. These proposed changes, highlighted below, are being considered for possible inclusion in the 2005 National Plumbing Code (NPC) and the 2005 National Building Code (NBC) as Interim Changes.

Hot water delivery in buildings

In 2004, a task group with broad stakeholder representation was formed to examine the health and safety risks associated with hot water delivery in buildings. The standing committee responsible for the NPC reviewed the task group report in June 2005 and recommended to the CCBFC that technical changes be made to the code requirements. These recommended changes are as follows:

- The temperature of water supplied to a shower, bathtub or lavatory shall not exceed 49°C in all buildings.
- Service water heaters shall be set to provide a water storage temperature of not less than 60°C in all buildings.

The CCBFC concurred that this is an urgent matter and agreed to submit the proposed Interim Changes to the 2005 NPC and the 2005 NBC Part 9 to public review.

ASME/CSA B125 plumbing fittings

The CCBFC also agreed to take to public review proposed Interim Changes to reference new ASME/CSA B125 standards. The CSA B125 standard dealing with plumbing supply and waste fittings has been harmonized with the ASME standards, which have a similar scope. Referencing the ASME/CSA B125 standards in the 2005 NPC would complete the harmonization process.

ASTM 2190 insulating glass

At a meeting held in April 2004, the Commission reviewed a request to add a reference to a new ASTM E 2190 standard on insulating glass to Part 9 of the 2005 NBC even though the proposed change had not gone through the normal public review process. The Commission did not agree to this request and asked that it go to public review at the earliest opportunity.

Public review to be held in May and June 2006

The public review on the proposed changes related to these three issues is taking place in May and June 2006. The proposed changes are available on the National Construction Codes Web site at *http://www.nationalcodes.ca/publicreview*.

The public is invited to read the proposed changes and submit comments to increase the range of expert review on this subject and to allow those most affected by the proposed changes to give their feedback. Public comments received will be reviewed by the standing committees in the fall of 2006. The CCBFC will then consider the report and recommendations of the standing committees on these matters at its next meeting, which is planned for late November or early December 2006. If these proposed changes are approved by the CCBFC, they could be considered as Interim Changes for inclusion in the 2005 NPC and 2005 NBC.

CD-ROM Versions of Codes Soon Available

Readers are reminded that the CD-ROM versions of the 2005 NBC, NFC and NPC will be released around the end of June 2006. Also available for purchase then will be:

- User's Guide – NBC 2005, Application and Intent Statements (CD-ROM only)
- User's Guide – NFC 2005, Application and Intent Statements (CD-ROM only)
- User's Guide – NPC 2005, Application and Intent Statements (CD-ROM only)
- User's Guide – NBC 2005, Structural Commentaries (Part 4 of Division B) (printed version and CD-ROM)

Watch for the CD-ROM versions in the NRC Virtual Store at *http://www.nrc.gc.ca/virtualstore*.

For more information on the 2005 National Construction Codes, please visit the National Construction Codes Web site at *http://www.nationalcodes.ca*

John Archer is with the Canadian Codes Centre of the NRC Institute for Research in Construction. He is Secretary of the Canadian Commission on Building and Fire Codes.

Further information about the proposed Interim Changes can be obtained by calling (613) 993-9960, or e-mail codes@nrc-cnrc.gc.ca.

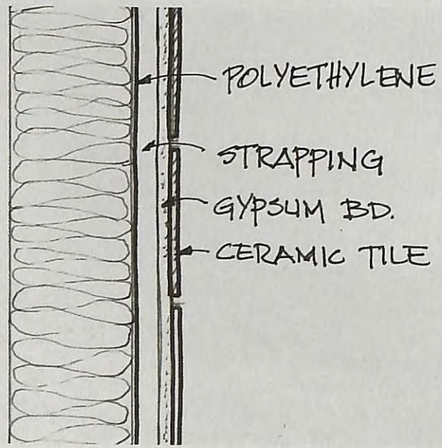
Using Drywall in Bathrooms

Gypsum board must not be exposed to high moisture levels for extended periods of time. Water-resistant gypsum board is not waterproof, and is not to be used in high humidity areas such as around tubs, steam rooms, indoor swimming pools, saunas, or showers.

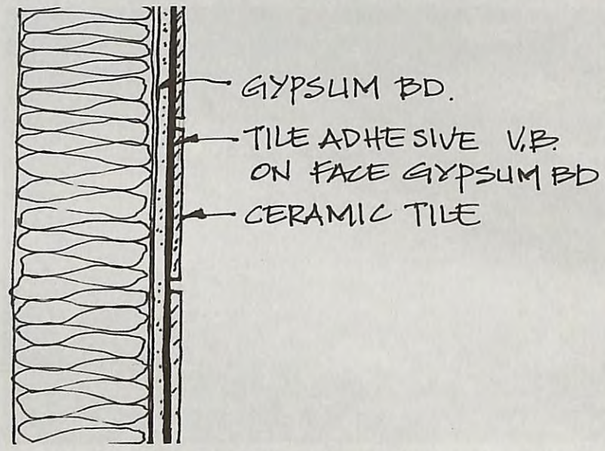
Gypsum board is often used as a base for tiles in wet areas, but it must not be foil-backed and must not be applied directly over a vapour barrier. Where water-resistant gypsum backing board is the substrate for ceramic tile on exterior walls requiring a vapour barrier, a uniform skim coat, not less than 1/32" (0.8 mm) thick, of water-based type I ceramic tile adhesive (ANSI A136.1) should be applied on the face of the gypsum board to create a vapour retarder.

If polyethylene is used as a vapour barrier for the house, it should be stopped in the area where the ceramic tile is used. Where a polyethylene air barrier must be used to provide a continuous membrane, an alternate that avoids creating a double vapour barrier must be used. One is to install the drywall on strapping, with an interior vented space, not unlike an interior rain screen.

The figures show two alternatives.



If polyethylene is used as the air/vapour barrier, the drywall should be placed on strapping – in effect creating an interior rain screen.



If drywall is attached directly to the framing, the vapour barrier should be applied on the face of the gypsum board, under the tile. There should be no poly behind the drywall.

Podcasts as a training tool?

Herman Rebneris in Victoria has an interesting idea. If Podcasting is available for farmers, could it also be used to affordably educate and upgrade the construction industry. Can or should a Red Seal Carpenter get upgrades in this way? Would voice be better then written content? We do listen to the radio when we drive, and a boom box seems to be a fixture on every construction site. Do we need a new innovative tool to reach our industry who are overburdened with too much written information?

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